

## EVALUATION OF CLOUD PATTERN CHARACTERISTICS

### DEFINITION OF TERMS

**Equator** – Great circle encircling Venus at 0° latitude (90° from the North and South polar axes).

**Equatorial band** – By our definition, the band of latitude ranging from 30° N. to 30° S.

**Hemisphere** – Half the surface of the sphere defined by ranges of latitude (Northern or Southern Hemisphere) or longitude (Eastern or Western Hemisphere); also is sometimes applied to the illuminated (**day side**) or the **night side** half of the planet.

**Latitude** – Spherical coordinate defined by a constant distance (in degrees) measured from the Equator (0°), positive northward and negative southward, as in Earth coordinates. The circle produced at a constant value of latitude is called a **small circle**.

**Longitude** – Spherical coordinate (in degrees) measured along any parallel measured positive eastward from the **Prime Meridian** (0° East longitude). The convention on Venus is that longitude ranges eastward from 0° to 360° in contrast with the convention adopted on Earth (-180° to +180°).

**Mid-latitude band** – By our definition, the band of latitudes ranging from 30° to 60° in either Northern or Southern Hemisphere.

**Polar cap** – By our definition, the range of latitudes from 60° to 90° capping the North Pole and South Pole.

**Polar hood** – Dark clouds that frequently are present at high latitudes in the polar caps.

**Prime Meridian (P.M.)** – Half of the great circle encircling Venus from the South Pole to the North Pole. The Prime Meridian, by convention, defines the 0° meridian.

**Scallop** – Frequently the edges of Venusian clouds are not smooth and linear but they present a series of irregular bumps or undulations having a range of amplitudes and wavelength. Usage of the term is thus subjective and is best understood with visual examples.

### IMAGES AND GRATICULES

The pair of illustrations below show the comparison of an image at left and its corresponding frame of reference, the map *graticule*, at right. The coordinate system for Venus is exactly the same as Earth's, with one major exception: Longitudes are always positive, measured to the East from the Prime Meridian (0°) (heavy line) to 360°. In the illustration, however, the conventional Earth style is used.

The graticule was plotted using parameters computed by the JPL Horizons online ephemeris program. The small + symbol in the center of the graticule is the sub-observer point; note that the latitude of the sub-observer point (the little + symbol at the center of the graticule) is only a few degrees north of the Equator and is never more than  $\pm 3.4$  degrees. As a result, the far polar regions on Venus are for all practical purposes invisible from Earth. Note that in the illustration, the  $80^\circ$  N. parallel is barely visible due to severe foreshortening.

If the graticule is sized to match the diameter of the image, overlaid on the image, and rotated so that the poles are aligned with horns of the crescent, a reasonable approximation of a Venus globe is achieved.

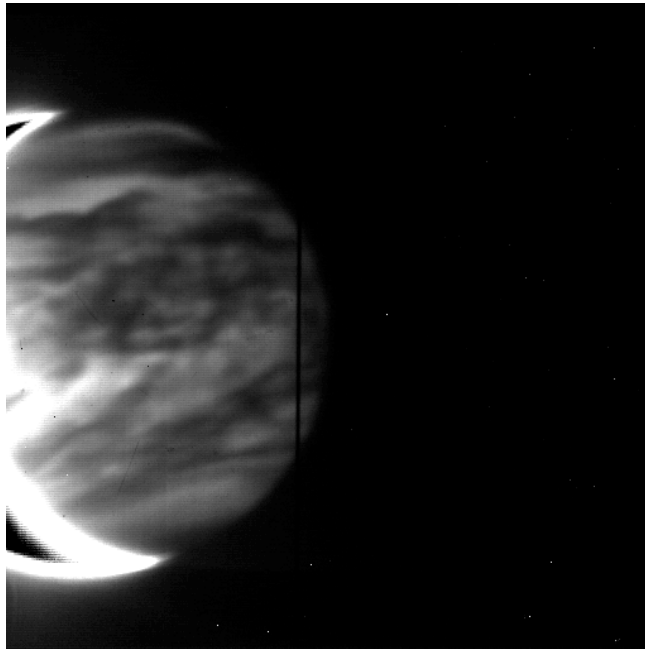
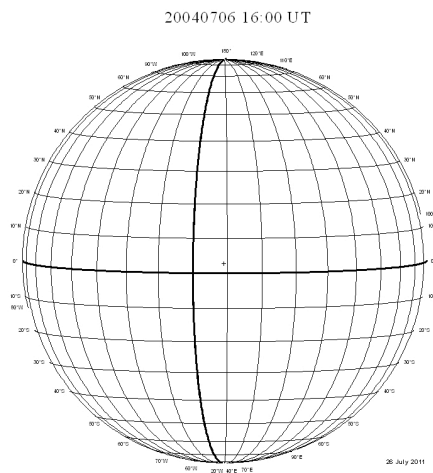


Image: 6 July 2004.



Graticule: 6 July 2004.

## CHARACTERISTICS OF CLOUD PATTERNS

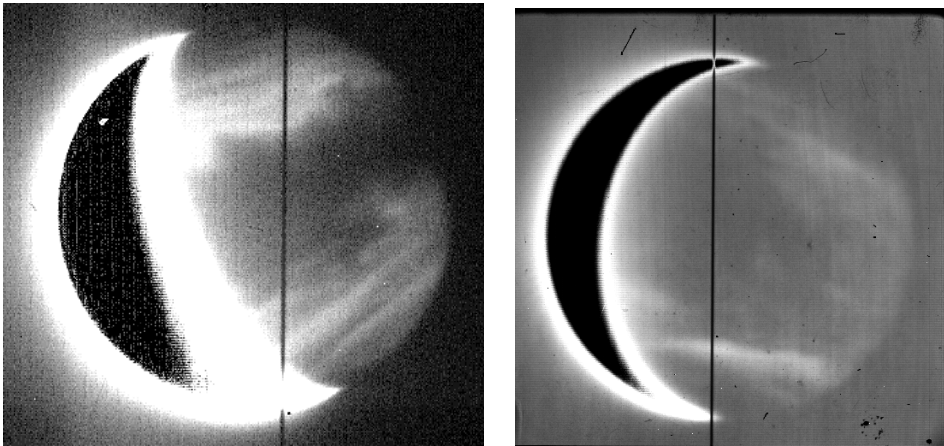
Six characteristics of each Venus image are to be evaluated on a five-point (1-5) scale. The ratings range from *no* expression (1) to a *full* expression (5) of a characteristic. Because the evaluations are strictly subjective, some disagreement may be expected among observers of a particular characteristic.

The six characteristics are: Equatorial Cloud Band; Scalloped Edges; Mid-Latitude Bands; Hemispheric Symmetry; Polar Hood; and Continuity of Clouds.

## Characteristic #1 Equatorial Cloud Band

Description: Prominent cloud formations often extend across the night side hemisphere of Venus and occasionally a band (or several) is aligned approximately E-W parallel to the Equator. The criterion evaluated is the extent to which the Equatorial cloud band is visible; visibility depends upon the image contrast between the cloud and the background.

- 1: An equatorial band is not present
- 2: Slight banding is observed
- 3: The band is apparent but does not extend across the entire night side hemisphere
- 4: The band extends across the night side hemisphere but has low contrast (medium gray)
- 5: The band is prominent and well-defined, with high contrast, and extends across the night side hemisphere



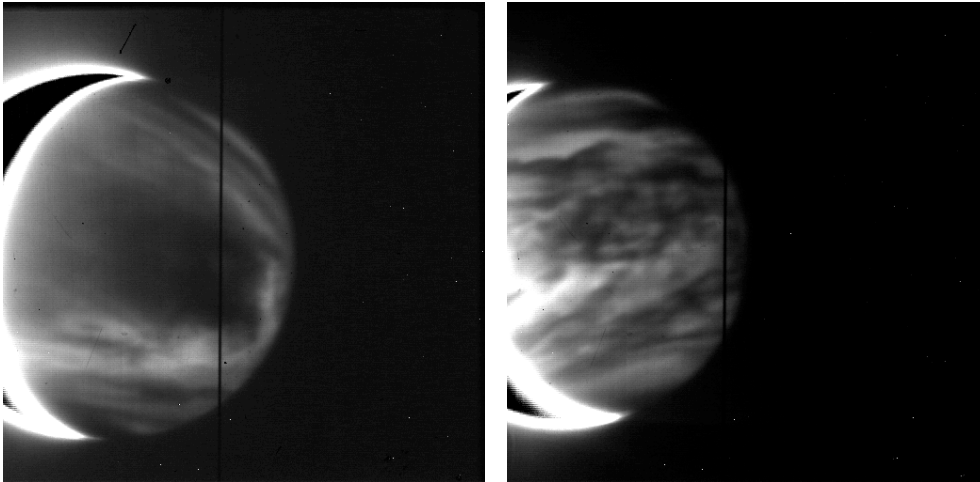
Left Image: *13 May 2001*. A major equatorial cloud band extends completely across the nightside hemisphere and displays large amplitude scalloping on both northern and southern sides of the band (see Characteristic #2 below). Several much narrower bands are apparent at mid-latitudes (see Characteristic #3 below). **Characteristic #1: 4**

Right Image: *8 September 2007*. A diffuse but wide equatorial band, extending from high latitudes in both hemispheres, is incomplete because it does not extend completely to the Eastern limb. There is no obvious scalloping. Note several, much narrower, mid-latitude bands at high latitudes. **Characteristic #1: 4**

## Characteristic #2 Scalloped Edges

Description: Equatorial cloud band displays scalloped edges.

- 1: Scalping is not present
- 2: Scalping is barely visible
- 3: Moderate scalloping
- 4: Strong scalloping
- 5: Exceptional scalloping
- N: Scalping on northern edge of band
- S: Scalping on southern edge of band



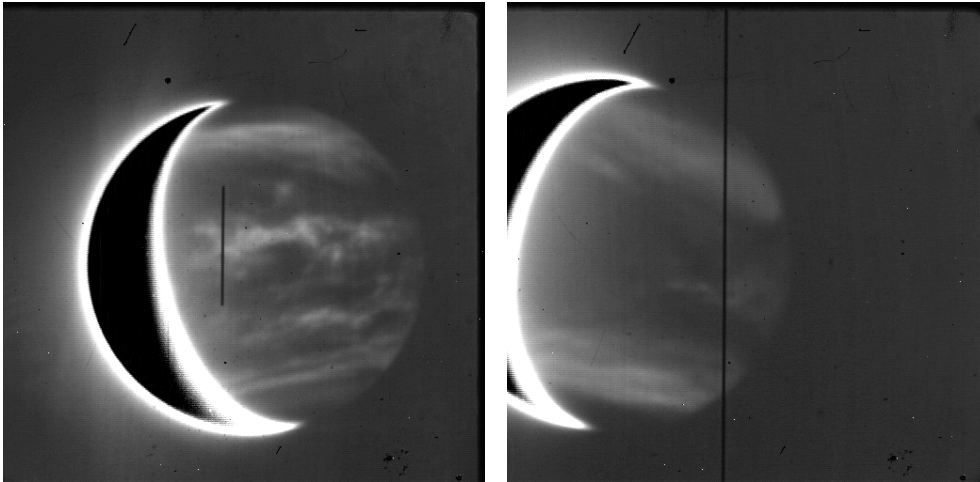
Left Image: *13 September 2007*. In this image, an equatorial band displays several irregularly spaced, large amplitude scallops along the southern edge of the band; there is no significant scalloping along the northern edge of the band. **Characteristic #2: N1; S4**

Right Image: *6 July 2004*. This irregular equatorial band is not centered on the Equator but does display moderate scalloping along the southern margin. **Characteristic #2: N1; S3**

### Characteristic #3 Mid-Latitude Bands

Description: Cloud bands are observed at mid-latitudes.

- 1: No mid-latitude bands are present
  - 2: Slight mid-latitude banding is observed
  - 3: The mid-latitude band(s) is apparent but does not extend across the night side hemisphere
  - 4: The mid-latitude band extends across the night side hemisphere but is low contrast (medium gray)
  - 5: The mid-latitude band is prominent, dark gray or black, and extends across the night side hemisphere
- N: Indicates that at least one mid-latitude band is located north of the Equator  
S: Indicates that at least one mid-latitude band is located south of the Equator  
(n): Indicates number of bands (two or greater)



Left Image: *9 July 2007*. One wide mid-latitude band in the northern hemisphere and at least two thinner mid-latitude bands in the southern hemisphere are observed, in addition to a prominent equatorial band. They all extend across the night side hemisphere. The northern band displays minor scalloping on its southern edge while the southern bands display no scalloping. **Characteristic #3: N5; S4(2)**

Right Image: *16 September 2007*. This image displays an interesting combination of two mid-latitude bands, one in each hemisphere, merging obliquely with an incomplete strong equatorial band. Thus the mid-latitude bands are not strictly zonal. **Characteristic #3: N4; S4**

### Characteristic #4 Hemispheric Symmetry

Description: The criterion is the extent to which symmetry is observed between the northern and southern hemispheres. Again the evaluation is subjective.

- 1: No symmetry is evident (asymmetric)
- 2: Slightly symmetric
- 3: Neither totally symmetric nor totally asymmetric
- 4: Strongly symmetric
- 5: Completely symmetric

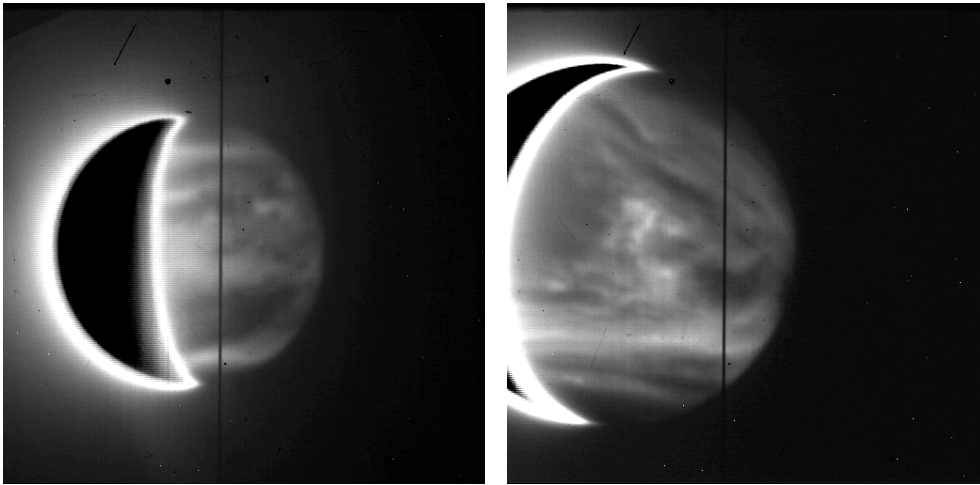


Image: *18 December 2010*. No significant equatorial band, prominent mid-latitude southern bands, less prominent northern mid-latitude bands. **Characteristic #4: N4; S3**

Right Image: *14 September 2007*. In this image, a short equatorial band near the terminator and another short equatorial band near the eastern limb, are interrupted by a bright gap in the clouds. There are oblique mid-latitude bands in the northern hemisphere and several zonal bands in the southern hemisphere. Prominent polar caps. **Characteristic #4: N4; S3**

### Characteristic #5 Polar Hood

Description: Polar hoods (clouds observed near the poles) are evaluated on the basis of the contrast to adjacent cloud patterns at lower latitudes.

- 1: Polar hood not observed
- 2: Polar hood slightly observed (low contrast with adjacent cloud feature at lower latitudes)
- 3: Polar hood observed (medium contrast)
- 4: Polar hood observed (stronger contrast)
- 5: Polar hood black (very strong contrast)
- N: North polar hood
- S: South polar hood

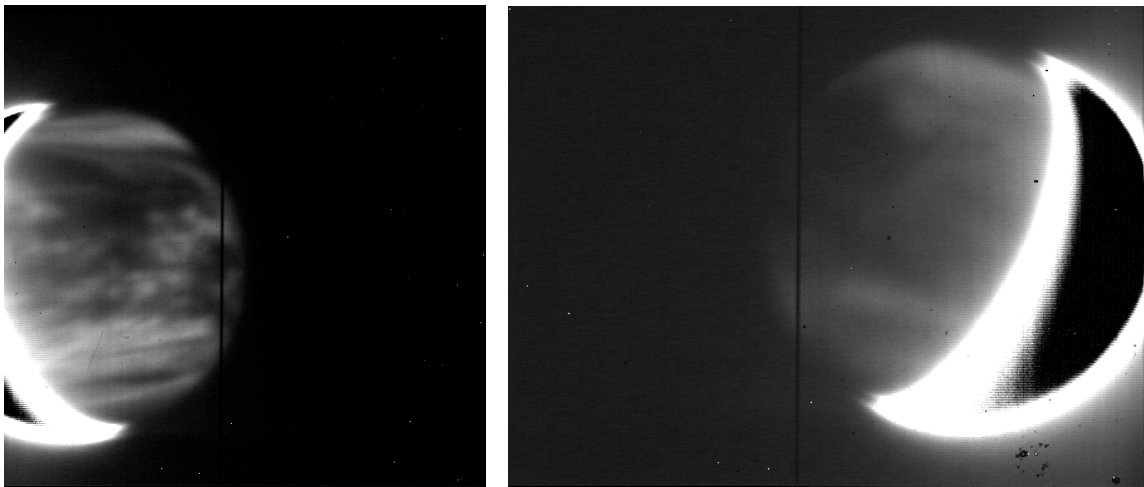


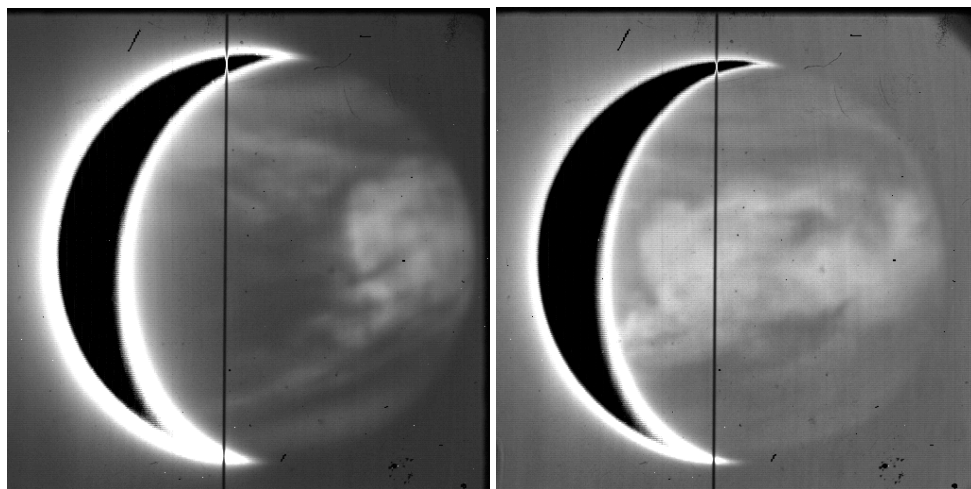
Image: 8 July 2004. Both polar hoods are prominent and dark. *Characteristic #5: N4; S4*

Right Image: 19 September 2002. The north polar hood is dark and prominent and the south polar hood barely visible. *Characteristic #5: N4; S2*

### Characteristic #6 Continuity of Clouds Observed Over Several Days

Description: Cloud features persist from one observation day to the next. The criterion evaluates the extent of continuity of features relative to previous day.

- 1: Continuity not evident
- 2: Continuity of one feature
- 3: Continuity of several features
- 4: Continuity of many features
- 5: Continuity of a large number of features



Images: *5 February 2006 (left) and 6 February 2006 (right)*. Large equatorial band moves westward and equally prominent equatorial gap follows one day later. Similarly, narrower northern and southern bands are distinguished over the interval. Excellent example of continuity. **Characteristic #6: 5**